

# The Role of ‘Intersectional Capital’ in Undergraduate Women’s Engagement in Research-Focused Computing Workshops

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**Abstract**—This paper examines how undergraduate women are supported in computing across their multiple and interlocking social identities of gender, race/ethnicity, and socioeconomic status. Through a mixed-methods study of women’s participation in Google-sponsored computing research workshops at 29 U.S. universities, contextualized by both science capital theory and intersectionality theory, we developed a novel theoretical framework of Intersectional Capital. Overall, survey and interview data show the workshops helped women foster a sense of belonging and professional identity responsive to their intersectional identities, encouraging their pursuit of and persistence in computing research because they were able to build Intersectional Capital. Intersectional Capital provides a lens through which to analyze and design equity-focused interventions in computing education and other disciplines through a constellation of components that help students develop confidence, gain skills, and participate in a larger community where they are supported in developing and presenting their entire selves as computer scientists. Themes observed from the study inform recommendations for cultivating Intersectional Capital.

**Keywords**—Computer science, undergraduate research, science capital, intersectionality, mentorship, identity, counterspaces

## I. INTRODUCTION

Marginalization and inequitable representation in computing are of national-level concern: women who identify as African-American/Black, American Indian/Alaska Native/Native American, Hispanic/Latinx, and/or Native Hawaiian/Pacific Islander (AAHN) earned only 7.8% of all computer science (CS) bachelor’s degrees awarded in the U.S. and Canada in 2019 [1]. Among other influencing factors, women in undergraduate computing programs face social barriers such as acute isolation and alienation, bias, discrimination, and stereotypes of women in computing [2]–[4]. They must coexist

within a predominantly male academic discipline that does not center their experiences [5]. They also have to negotiate their intersectional identities across gender, race/ethnicity, socioeconomic status (SES), and other dimensions as they navigate academia [2], [6], [7].

To better understand undergraduate women’s interest and engagement in computing, it is essential to investigate whether their multiple and interlocking social identities are affirmed and supported meaningfully. Women report that their social identities are not valued nor taken into account, leading to a low sense of belonging [7], [8]. Students from lower SES are also less likely to have access to and pursue computing [9], [10]. The effects of class and status privilege are advantages for some (e.g., preparatory privilege), but barriers to pursuing computing for those from lower SES (e.g., deficit thinking) [11], [12]. This systemic lack of support for women’s intersectional identities leaves them questioning whether they can become computer scientists, which serves as a predominant influence on why AAHN women are severely underrepresented throughout the field of computing.

Counterspaces encourage women’s participation across their intersectional identities [13]. Counterspaces “created closer to the center of the dominant power structure of STEM education have the potential to be spaces of interactive learning that may ultimately contribute innovative and transformative STEM perspectives and ideas, as well as to interrupt the structures, norms of success, and privilege of the dominant culture of STEM” [13, p. 237]. Intentionally designing research-focused workshops as counterspaces in undergraduate computing for students who identify as AAHN and/or women has been shown to improve their academic and social success [14]–[20]; workshops such as those supported by Google’s exploreCSR program (“Program”).

## A. Program Overview

The Program aims to increase the number of students who identify as AAHN and/or women pursuing graduate studies and research careers in computing, as the enrollment of these students in CS PhD programs in the U.S. and Canada decreased 6.7% from 2018 to 2019 (from 493 to 460; 3% of all PhD enrollments) [1], [21]. The Program provides funding, evaluation, and a community of practice to faculty who design and execute research-focused workshops during the academic year. The first two cohorts of the Program engaged 2,153 participants across 29 U.S. institutions, 74% of whom identified as women. Program evaluations indicate that these experiences increase participants' self-efficacy, graduate school interest, attitudes about computing, research skills, professional identity, and sense of belonging [15], [22]. All workshops shared common programmatic features such as hands-on, collaborative projects, tiered mentoring, and project showcases. Panels, breakouts, and speakers covered career planning topics, and graduate school financing, planning, and expectations. Workshops also included identity-focused topics, such as work-life balance, stereotype threat, mindset, and imposter syndrome. Regardless of the research focus area for the workshops (e.g., AI, Robotics, HCI) all research was framed within socially-relevant computing, a factor known to positively influence women's interests in computing [4]. Workshops were offered over the course of a weekend, semester, or academic year; no differences in outcomes have been observed by workshop length.

## II. RELATED WORK

Exploring dimensions of science capital is essential to understanding undergraduate women's experiences as computer scientists across their identities. Science capital is defined as a "...conceptual device for collating types of economic, social and cultural capital that specifically relate to science—notably those which have the potential to generate, use, or exchange value for individuals or groups to support and enhance their attainment, engagement and/or participation in science" [23, p. 5]. Studies show that students with more science capital are more likely to pursue science in the future, and that undergraduate men have higher levels of science capital [24], [25]. Even among students who have similar levels of cultural capital, their level of science capital can impact their likelihood to pursue science at the postsecondary level [24].

An intersectional lens is critical when examining women's social identities and unique lived experiences in undergraduate computing programs. Intersectionality theory is "a theoretical and methodological approach to understanding the meaning and consequences of holding multiple co-constructing categories of social group membership" [26, p. 230]. Women in STEM face a double bind at the intersection of their multiple and interlocking social identities [27]. Women scientists endure sexism, racism, a chilly campus climate, low sense of belonging, being few in number in their degree programs, STEM identity challenges, and the perception that they are illegitimate scientists [2], [26]–[31].

In addition to the role of counterspaces, agency, cultural competence, authenticity, and content that is culturally relevant, socially impactful, and justice-centered contribute to meaningful and engaged sustainment in computing of students who identify as AAHN and/or women [4], [32]–[35]. Although women lack access to mentors, mentorship is critical to women's retention and success in computing research [16], [17], [36], [37].

## III. METHODS

The objective of this study is to explore the effects of the intersecting psychosocial, cultural, and economic facets of women's identities on their experiences in undergraduate computing programs, and how research-focused interventions can be designed to cultivate community and identity in computing for women. The study was informed by the research questions: 1) How do research-focused workshops create community and identity in computing research pathways? 2) What experiences are salient for women that support intersectional identities across racial/ethnic and socioeconomic backgrounds to encourage their successful persistence in computing?

A mixed-methods study across two Program cohorts included interviews with students who identified as women ( $n = 67$ ; pseudonyms used) and pre/post workshop surveys of student attitudes. The survey instrument was designed for undergraduate research programs [38]–[40], with items rated on a 5-point Likert scale. There were 525 participants in the first cohort pre-survey (48% response rate), and 532 students in the second cohort pre-survey (60% response rate). Demographic information collected in interviews and surveys (gender, race/ethnicity, SES) was self-reported. Both cohort years of survey data were combined and included only the respondents who indicated their gender as "female." The SES item is a subjective index on a scale of 1-10 [41], which has been truncated to three levels for analysis and discussion: Low (1-4), Medium (5-7), and High (8-10). Our study treats SES as a feature of social class that is relative and contextual, as subjective measures of SES have been demonstrated to be accurate in self-report measures [42].

The demographic portrait of this study sample included 67 women who participated in interviews, half of whom identified as middle-class, and 73% as AAHN. Self-reported race/ethnicity from pre-survey responses ( $n = 721$ ) indicated 36% AAHN, 36% Asian, and 26% White; reported SES levels were 34% low, 37% medium, and 26% high. As themes emerged in the qualitative interviews, we returned to the quantitative data to conduct a cursory investigation (using multivariate analysis of variance, MANOVA) of whether there were interactions between students' intersectional identities (i.e., gender, race/ethnicity, and SES) and key constructs (Sense of Belonging, Professional Identity, Mentoring Satisfaction).

## IV. RESULTS

Reviewing themes observed from the results of the study alongside what we know from the related literature, we posit a new theoretical framework - Intersectional Capital.

Intersectional Capital describes a set of environmental and interpersonal conditions that enable students (especially those who identify as AAHN and/or women) to pursue STEM and computing by validating and leveraging their multiple, interlocking identities as assets. Intersectional Capital acknowledges students' unique lived experiences comprehensively while equipping them to navigate systemic barriers by connecting them to opportunities that enhance their self-efficacy, sense of belonging, actionable skills, community, and professional identities. Three tenets central to this framework, Authentic Professional Identity, Intersectional Mentoring, and intersectional Peer Community, address how interventions can support student persistence in computing inclusively across their social identities.

#### A. *Authentic Professional Identity*

A Black woman, Kira, was intimidated to major in computing at her institution due to the competitive environment among other women computing majors, which adversely impacted her academic success. However, she shared that "I got a lot of advice and I was able to take a lot of things away from that [workshop] that I don't get on a daily basis. [...] I took away so much knowledge and so much gems from that [workshop] just in three days."

The pre-survey MANOVA examined any mean differences for Professional Identity based on race/ethnicity and SES, and was significant for the main effect of race/ethnicity. The omnibus Wilks' Lambda (.229) indicated the combined dependent variables differed on average among student race/ethnicity groups, = .962,  $F(6,1376)$   $p = 0.00$ . Follow-up univariate F statistics suggest a significant difference in Professional Identity at pre-survey, = 7.866,  $F(3, 21.805)$   $p = 0.000$ . Professional Identity was significantly higher among women identifying as AAHN ( $M = 2.98$ ) compared to women identifying as white ( $M = 2.51$ ) at pre-survey; this effect was not observed at post-survey.

#### B. *Intersectional Mentorship*

A Latinx woman, Ava, began to think differently about herself as a computing major because the workshop "helps you to see ... role models [who] went for [their] Master's and maybe like a PhD ... so when you see those role models, I think you realize that you have a lot of opportunities." Direct access to role models catalyzed Ava's awareness of available career pathways. Ava was empowered by having mentors who understood her specific concerns about pursuing graduate school and a research career in computing. Workshop mentors helped Kira build strategies to navigate computing as a Black woman. Survey findings showed high ratings for Mentorship ( $M = 3.97$ ) without any differences observed by race/ethnicity and SES.

#### C. *Intersectional Peer Community*

Kira shared that she felt confidence and affirmation from the workshop because of the support she received from peers like her. "This [workshop] opened up a new realm of grad school,

[which I] hadn't given a thought. And just the fact that there are so few women in computer science, I know that now is the time to pursue any kind of dream I may have in the field." After attending the Program workshop, Kira reported a new sense of community that she was able to cultivate with peers who reflected her identities and experiences: "Now I have a whole new group of people that I can relate to."

The omnibus Wilks' Lambda (.964) was significant at post-survey for the main effect of SES, indicating the combined dependent variables differed on average among student SES, = .2445,  $F(6,794)$   $p = 0.024$ . Post-survey follow up univariate F statistics suggest a significant difference in Sense of Belonging by SES, = 2.492,  $F(6,14.215)$   $p = 0.022$ . Sense of Belonging was significantly higher for women at post-survey who reported higher levels of SES ( $M = 4.18$ ) compared to women who reported lower SES levels ( $M = 3.89$ ).

### V. DISCUSSION

The framework of and tenets of Intersectional Capital provide effective strategies for addressing the complexity of intersectional identities in computing persistence.

#### A. *Authentic Professional Identity*

Maintaining authenticity within computing as a woman, across intersectional identities, is challenging [13], [43]. Kira and Ava described how collaborating with a breadth of women like themselves, who validated and advised them on their particular experiences, was a powerful factor in developing a sense of Authentic Professional Identity. The Program created counterspaces to promote development of an Authentic Professional Identity, evident in the overall increase in Sense of Belonging and Professional Identity found in the survey. Additionally, Professional Identity had no observable differences between groups at post-survey, despite having differences at pre-survey, which indicates that the experiences closed the gap between race/ethnicity groups, and lifted all students' sense of Professional Identity. Authenticity, rather than assimilation, is revered in counterspaces [13]. The Program enabled students' values and lived experiences to be applied through socially-relevant and culturally-responsive computing research engagement. Additional strategies for building Authentic Professional Identity include showcasing career pathways where professionals have united their multiple identities authentically, and encouraging students to draft personal statements (e.g., for graduate school applications) with peer feedback in order to identify unique facets of each students' experiences and values in computing research they might not otherwise see for themselves.

#### B. *Intersectional Mentoring*

Intersectional Mentoring extends beyond traditional academic and professional mentoring; it actively supports and champions mentees' pursuit of computing from a place of awareness and empathy of the entirety of the psychosocial, cultural, and economic contexts of the mentees. Both Kira and Ava demonstrated the value of mentors who identified

and supported the realities they face in computing as Black and Latinx women. Survey findings showed high ratings for Mentorship across intersectional identities. A key strategy for Intersectional Mentoring employed by workshops in the Program is to discuss intersectional issues openly via panels and discussions (e.g., navigating social barriers in academia, selecting a research direction that reflects commitment to social justice). The mentors, not necessarily matched on intersectional identities to their mentees, were primed for awareness and support of intersectional factors.

### C. Intersectional Peer Community

Kira’s description of her experience of computing prior to the Program as being “judgemental,” “competitive,” and “not really open” shows that community is lacking in undergraduate computing programs. Sense of Belonging is a factor positively related to research engagement [16], [22], for which the Program has observed increases for participants [15]. Both pre and post-survey findings showed SES levels influencing women’s Sense of Belonging. Because Professional Identity was not different among women based on SES at post-survey, we believe that the Program’s creation of an Intersectional Peer Community may have offset the negative effects of class and ambient cues of belonging [44] on women participants’ engagement and identity in computing. We view Intersectional Peer Community as Kira described her experience, a large community of undergraduates across a diversity of identities who are mutually supportive of each others’ interest and engagement in computing. Strategies that were observed to build Intersectional Peer Communities included intentional outreach, messaging, and content meant to solicit and sustain participation of a critical mass of students who identify as AAHN and/or women. Collaborative activities that facilitate academic and social engagement are key catalysts for Intersectional Peer Communities.

### D. Cultivating Intersectional Capital

Our observations of differences by race/ethnicity and SES indicate that the Intersectional Capital framework enables a more precise examination of forces impacting students’ experiences. The differences found among students at the start and end of their program participation indicate that psychosocial, cultural, and economic factors influence the computing experience at varying degrees. Future work aims to explore intersectional experiences of students in computing across a greater breadth of gender identity, class, and cultural perspectives. Based upon the qualitative findings and the cursory quantitative exploration of intersectional identity factors, we are developing additional measures for future program cycles and evaluations to address Intersectional Capital that specify Authentic Professional Identity, Intersectional Mentoring, and Intersectional Peer Community.

Integrating Intersectional Capital into interventions like research-focused workshops is of vital importance to help students develop a sense of belonging, acquire technical and interpersonal skills, cultivate meaningful relationships, and

establish an empowering computing identity. Practitioners must intentionally curate a safe and collaborative counterspace for students to engage directly in computing across students’ intersectional identities; not just in gender and race/ethnicity, but acknowledging how all facets of their identities influence their experiences in computing, such as obligations as caretakers, interdisciplinary studies outside of computing, and commitments to social justice. Student participants of the Program shared that they are overrepresented as AAHN and/or women computer scientists within the workshops, visualize and connect with mentors and peers who share or validate their intersectional identities, and talk through the issues that they face in computing, which enables them to be themselves fully and completely in a field which has systemic barriers to their authentic participation. It is for the first time that many of these students have a collaborative and safe counterspace to call their own where they see themselves becoming computer scientists and attending graduate school. The message is not that students are accepted as AAHN and/or women with unique and rich experiences who do computing research, but that those very experiences are a direct asset to their professional identity and the field.

## VI. CONCLUSION

In support of efforts to broaden participation in computing of students who identify as AAHN and/or women, this study examined how undergraduate women are supported in the field through counterspaces like The Program’s research-focused workshops. The proposed framework of Intersectional Capital describes a collection of circumstances and experiences that supports the complexity of students’ intersectional identities across gender, race/ethnicity, social class, and other facets when engaging in computing. The psychosocial, cultural, and economic factors that make women a polyethnic group can be understood through the Intersectional Capital lens, which highlights the importance of an Authentic Professional Identity, Intersectional Mentoring, and Intersectional Peer Community. We plan to further develop Intersectional Capital as a construct and investigate how to integrate and scale Intersectional Capital into undergraduate programs in STEM, computing, and research. Implications from our current findings inform educational strategies to create counterspaces that cultivate Intersectional Capital in a way that specifically engages and interests undergraduate women in computing across students’ multiple identities.

## ACKNOWLEDGMENT

We appreciate the contribution from Deborah Holmes, Research Assistant at UNC Charlotte, on survey data analysis.

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